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(54) **ROTARY DIE CUTTER**

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B65C 9/22	(2006.01)
B29C 65/00	(2006.01)
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CPC ***B26D 7/265*** (2013.01); ***B26F 1/384*** (2013.01); *B26D 5/28* (2013.01); *B26D 7/0625* (2013.01); *Y10T 83/4833* (2015.04)

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See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

3,448,684 A *	6/1969	Faudemay	....	B21B 31/30 100/171
3,908,426 A *	9/1975	Aramaki	....	B21B 13/10 72/238

(Continued)

FOREIGN PATENT DOCUMENTS

DE	19814009	6/1999
EP	0899068	3/1999

(Continued)

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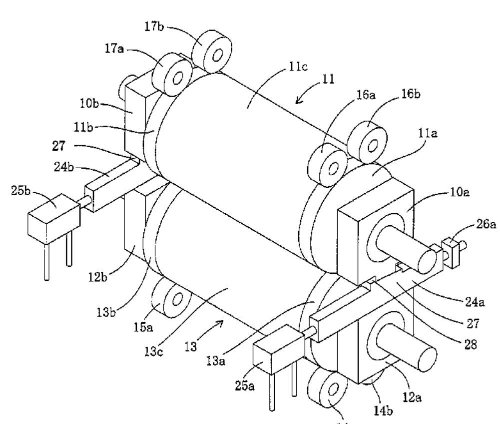
(57) **ABSTRACT**

Each pair of bearing units for each of magnet and anvil rollers are movable in a vertical direction. Each of large diameter portions of the anvil roller is supported by a pair of support rollers. Each of large diameter portions of the magnet roller is pressed against the corresponding large diameter portion of the anvil roller by a pair of press rollers. Each stopper is moved between a first position in which it projects into a clearance between vertically opposed bearing units and a second position in which it retracts from the first position. When the stoppers are located at the first position, the opposed large diameter portions of the magnet and anvil rollers separate from each other, and when the stoppers are located at the second position, the opposed large diameter portions of the magnet and anvil rollers contact with each other.

4 Claims, 6 Drawing Sheets



(51) **Int. Cl.**
B26F 1/38 (2006.01)
B26D 5/28 (2006.01)
B26D 7/06 (2006.01)

(56) **References Cited**

U.S. PATENT DOCUMENTS

4,205,596	A *	6/1980	Chesnut	B26D 1/626	100/170
4,255,998	A *	3/1981	Rudszinat	A24C 5/473	83/298
4,341,525	A *	7/1982	Wittkopf	B23D 35/007	493/370
4,359,919	A *	11/1982	Fuchs	B26D 7/2614	83/344
4,553,461	A *	11/1985	Belongia	B26D 7/00	83/342
4,759,247	A *	7/1988	Bell	B26D 7/2628	83/344
5,048,387	A *	9/1991	Niitsuma	B41F 13/62	83/344
5,058,472	A *	10/1991	Kakko-Chiloff	B23D 35/008	83/344
5,151,636	A *	9/1992	Winebarger	B26F 1/384	318/272
5,156,076	A *	10/1992	Rosemann	B26D 7/2628	100/168
5,174,185	A *	12/1992	Aichele	B26D 7/2628	83/346
5,388,490	A *	2/1995	Buck	B26D 7/2628	83/344
5,673,603	A *	10/1997	Aichele	B21B 31/30	100/168
5,765,460	A *	6/1998	Wathieu	B23D 36/005	83/311
6,694,873	B1 *	2/2004	LaBelle	B29C 59/04	101/23
7,299,729	B2 *	11/2007	Cox	B23D 35/008	83/343
7,594,461	B2 *	9/2009	Aichele	B26D 7/22	83/344
8,356,536	B2 *	1/2013	Madern	B23D 35/008	83/343
9,003,939	B2 *	4/2015	Dijon	B26D 1/405	83/343
9,156,180	B2 *	10/2015	Horii	B26D 7/18	
2004/0003699	A1 *	1/2004	Welch	A61F 13/15723	83/658

FOREIGN PATENT DOCUMENTS

EP	1799409	6/2007
JP	2003-237018	8/2003
JP	2012-161859	8/2012
WO	2014135265	9/2004

* cited by examiner

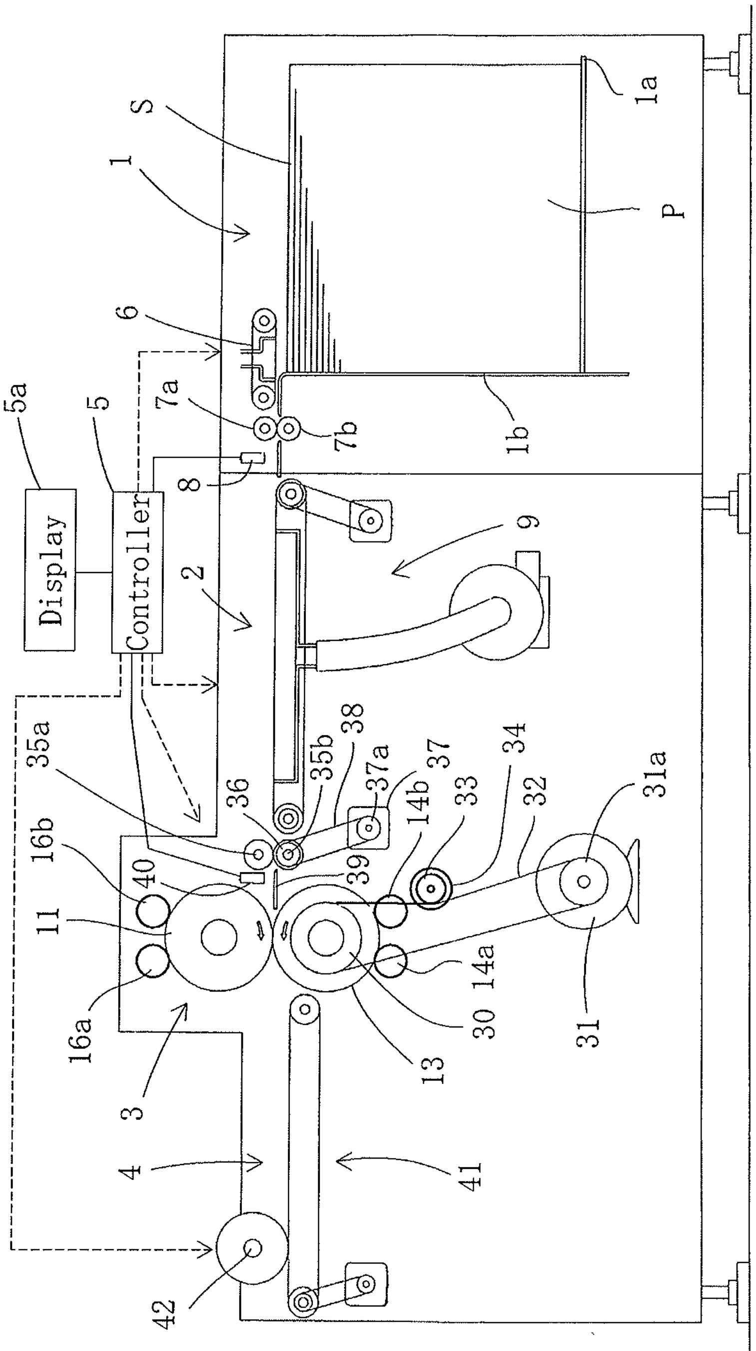

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FIG. 1

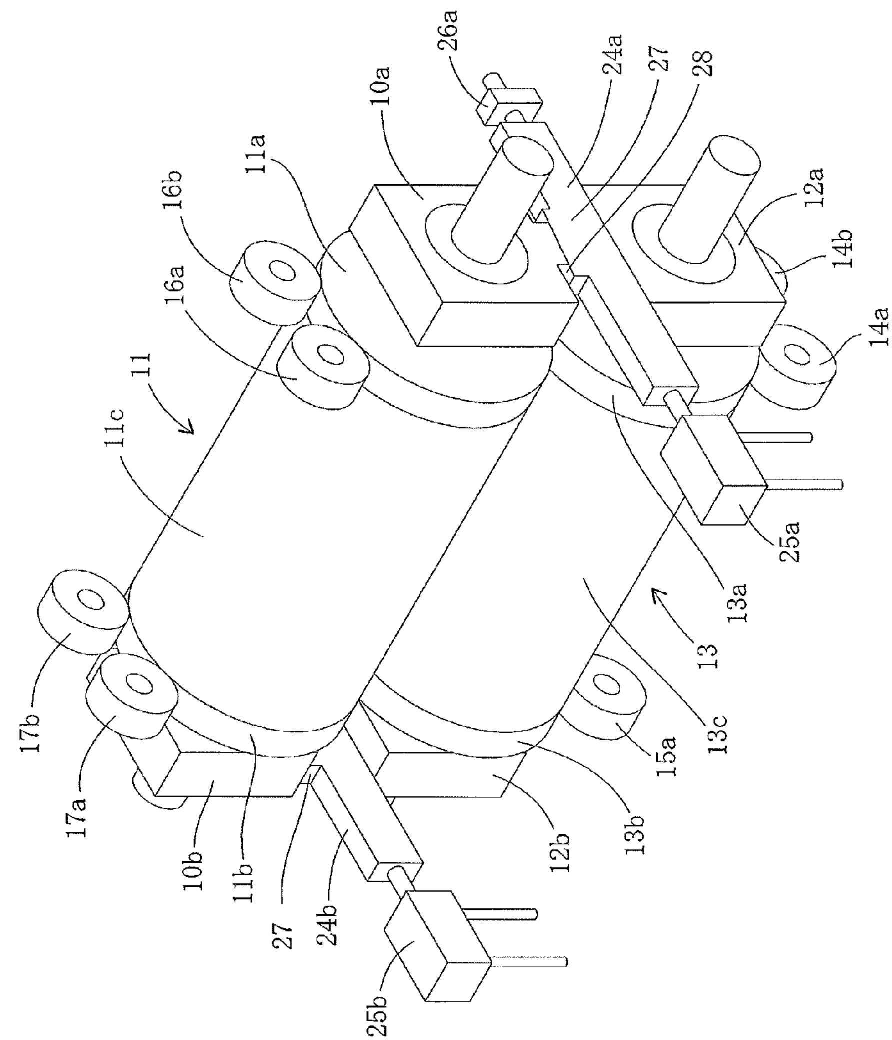
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FIG. 2

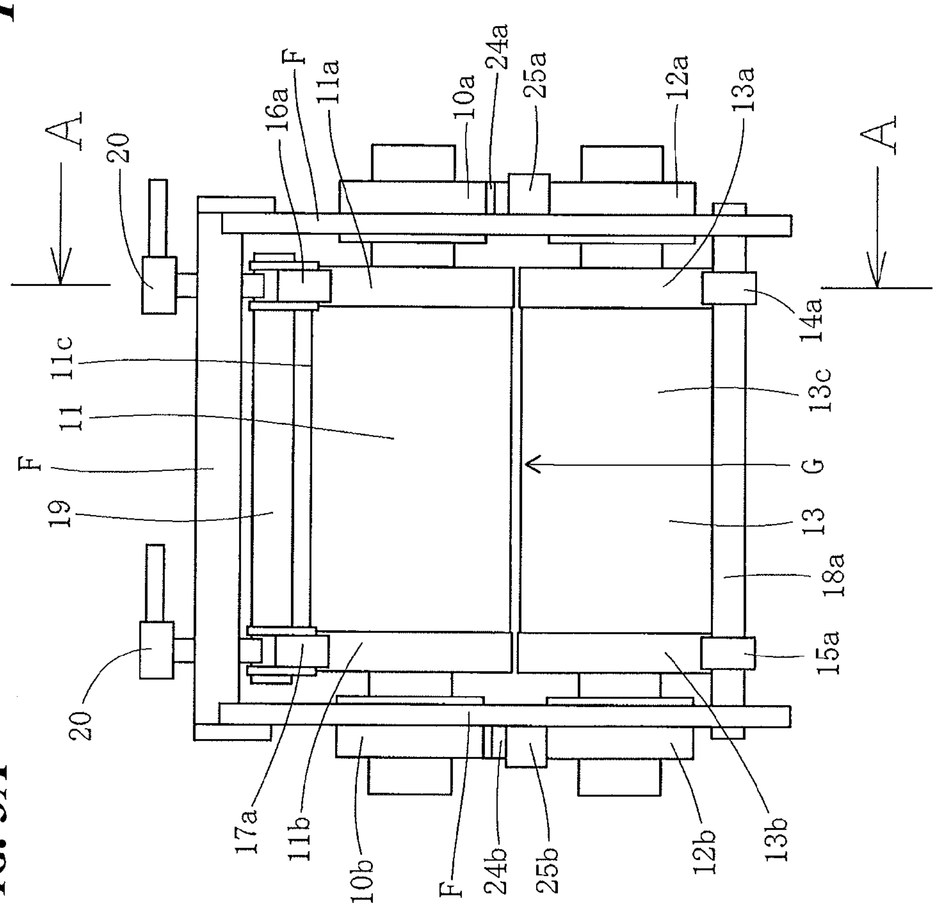

FIG. 3A

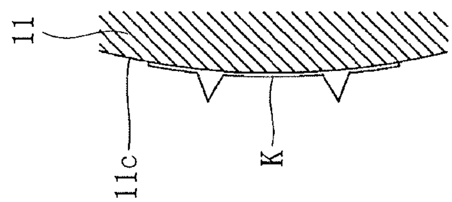

FIG. 3B

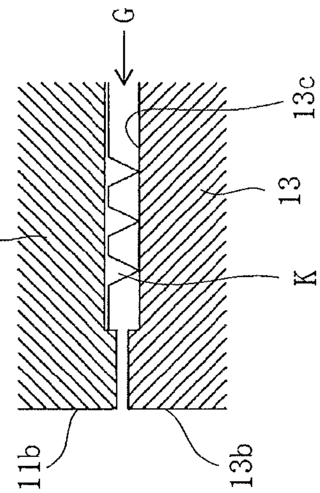

FIG. 3C

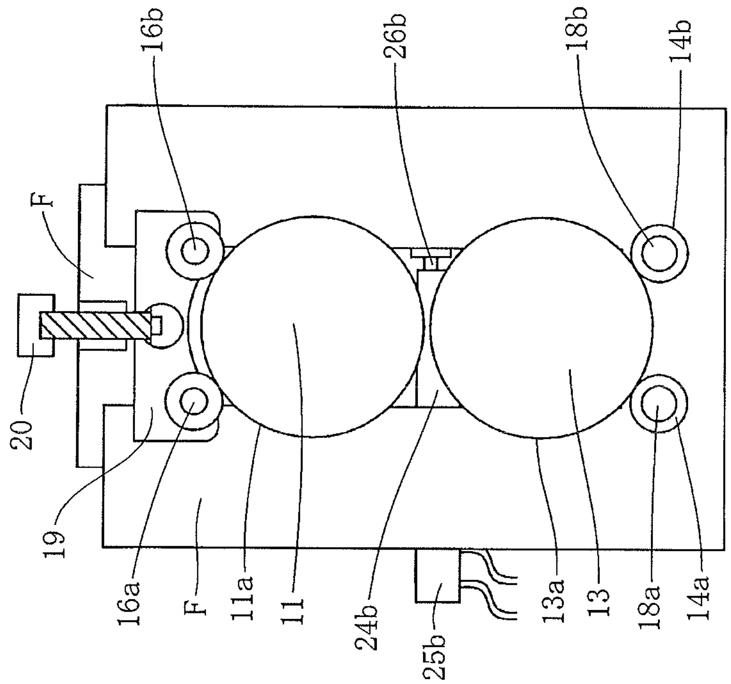
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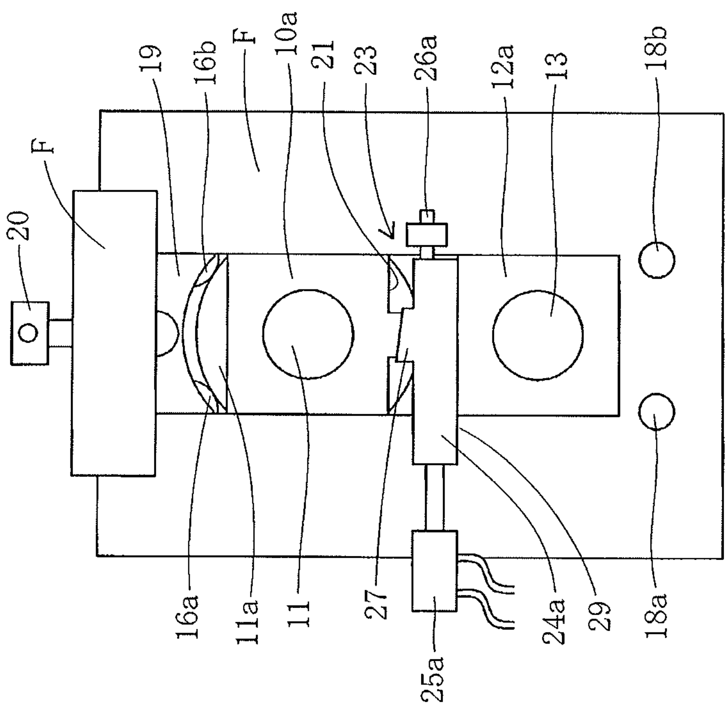
FIG. 4B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29
18a

FIG. 4A

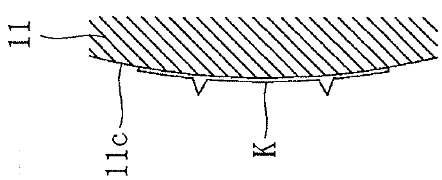

FIG. 5B

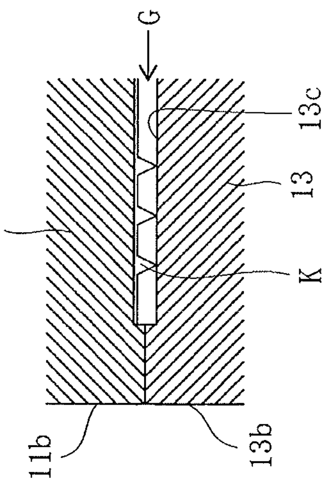

FIG. 5C

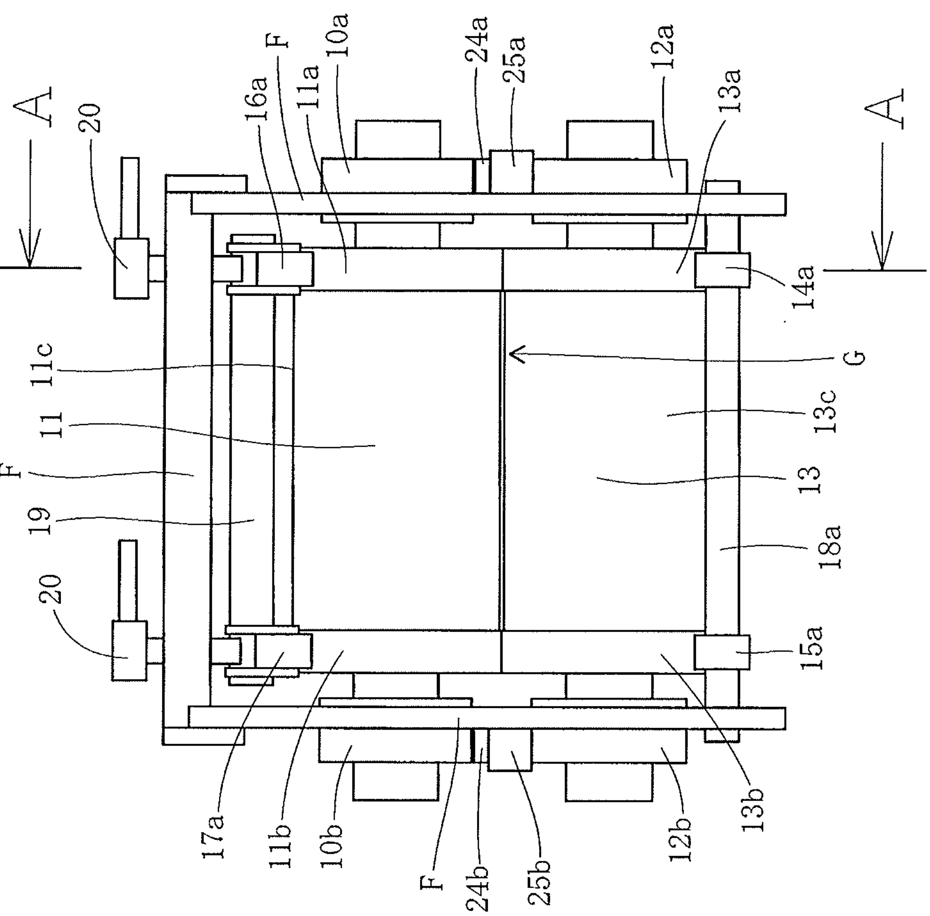

FIG. 5A

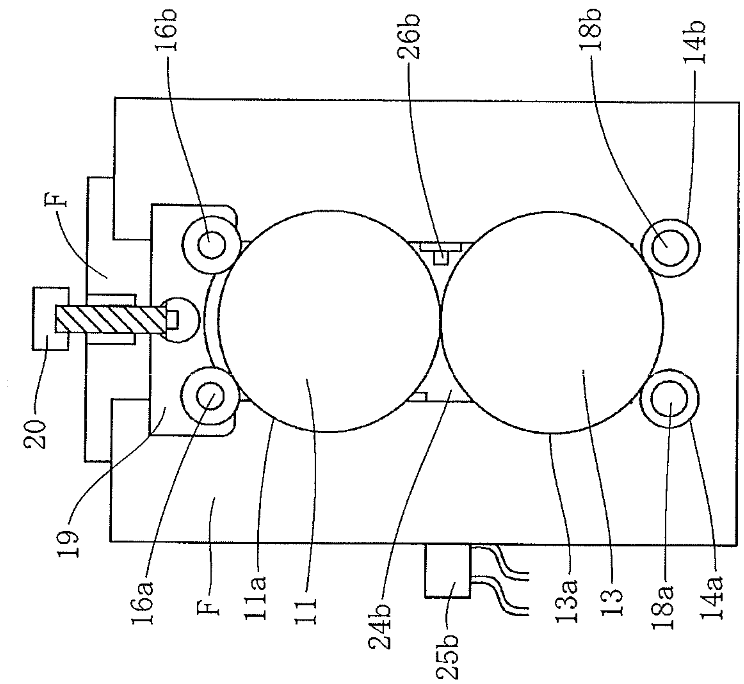
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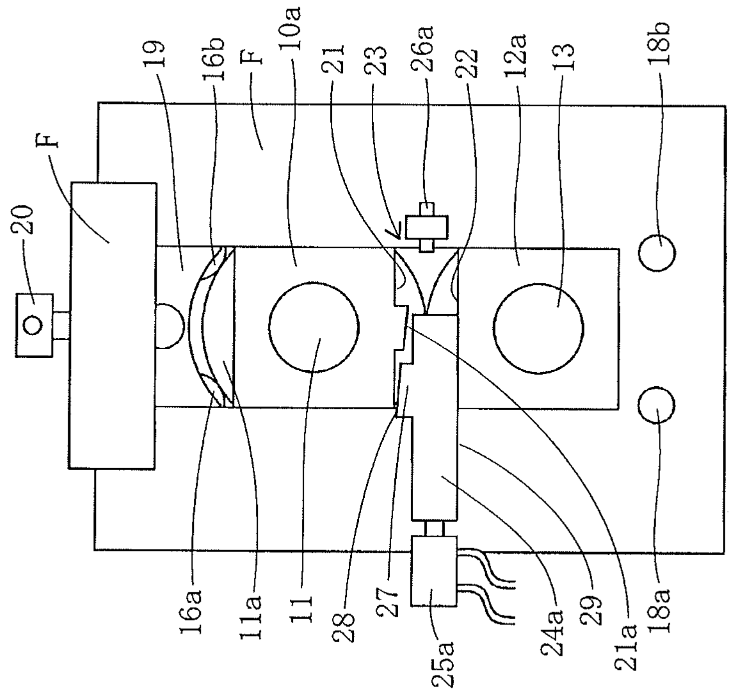
FIG. 6B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25a
24a
29
21a
18a

FIG. 6A

ROTARY DIE CUTTER

TECHNICAL FIELD

The present invention relates to a rotary die cutter having a pair of a magnet roller on which a flexible die is mounted, and an anvil roller arranged opposite to the magnet roller and punching out a sheet which is supplied one by one between the magnet roller and the anvil roller.

BACKGROUND ART

A conventional rotary die cutter comprises a magnet roller, an anvil roller arranged opposite to the magnet roller, a flexible die which is magnetically mounted on the magnet roller, and a sheet feed unit supplying a sheet one by one between the magnet and anvil rollers, in which the sheet supplied from the sheet feed unit is punched out by the flexible die (the term "punch" may be used to denote not only its original meanings but also "emboss", "score", "perforate" and so on. The same applies hereinafter.) while the sheet is conveyed by the magnet and anvil rollers (See, for example, JP 2003-237018 A and JP 2012-161859 A).

In such rotary die cutter, each of the magnet and anvil rollers forms large diameter portions (generally referred to as "bearers") at both ends thereof and a small diameter portion at intermediate portion thereof, and the small diameter portion extends between the large diameter portions. Then, when the magnet and anvil rollers contact with each other at their bearers, a gap corresponding to a height of the die is formed between the small diameter portions of the magnet and anvil rollers.

Then the die is magnetically mounted on the periphery of the small diameter portion of the magnet roller, and the bearer of the magnet roller and the bearer of the anvil rollers are pressed against each other in order to prevent a failure of punching by keeping the gap between the magnet and anvil rollers constant, and then the punching operation is performed.

However, according to such configuration, one type of the die whose height corresponds to the gap can only be used because the size of the gap between the magnet and anvil rollers cannot be changed. Therefore, a punching operation using various types of dies whose heights are different from each other is considerably inconvenient because a dedicated rotary die cutter is required for each type of the die.

SUMMARY OF THE INVENTION

Problems to be Solved by the Invention

It is, therefore, an object of the present invention to provide a rotary die cutter capable of using two types of dies whose heights are different from each other.

Means for Solving the Problems

In order to achieve this object, according to the present invention, there is provided a rotary die cutter comprising: a frame provided with a path of sheets to be conveyed; a pair of first bearing units arranged at both sides of the path and attached to the frame so as to be moved in a vertical direction; a horizontal magnet roller supported by the pair of first bearing units and extending across and perpendicularly to the path; a pair of second bearing units arranged above or under the pair of first bearing units and attached to the frame so as to be moved in a vertical direction; a horizontal anvil roller

supported by the pair of second bearing units and arranged opposite to the magnet roller, at least one of the magnet and anvil rollers forming large diameter portions at both ends thereof and a small diameter portion at intermediate portion thereof, the small diameter portion extending between the large diameter portions; a pair of support rollers attached to the frame and arranged under and opposite to each end of the lower roller of the magnet and anvil rollers so as to support the lower roller; a pair of press rollers arranged above and opposite to each end of the upper roller of the magnet and anvil rollers so as to be moved between a pressing position in which the pairs of press rollers press the both ends of the upper roller against both ends of the lower roller of the magnet and anvil rollers and a nonpressing position in which the pairs of press rollers retreat upward from the pressing position; a press mechanism attached to the frame so as to support and move the pairs of press rollers between the pressing position and the nonpressing position; a roller gap change unit attached to the frame and moving the bearing unit for the upper roller between a position in which the both ends of the magnet roller and the both ends of the anvil roller contact with each other and a position in which the both ends of the magnet roller and the both ends of the anvil roller separate from each other so as to switch between two different sizes of gaps between the intermediate portions of the magnet and anvil rollers, two different types of flexible dies whose heights correspond to the two different sizes of the gaps being able to magnetically mounted on the intermediate portion of the magnet roller; a pair of feed rollers arranged upstream of a pair of the magnet and anvil rollers; a first drive mechanism rotating the magnet and anvil rollers in such a way that the magnet and anvil rollers are rotated synchronously with each other at an equal circumferential velocity; and a second drive mechanism rotating the pair of feed rollers, wherein a sheet is supplied one by one between the pair of feed rollers, and punched by the flexible die while being conveyed through the gap between the magnet and anvil rollers by the pair of feed rollers.

According to a preferred embodiment of the present invention, a clearance is formed between each pair of the first bearing unit and the second bearing unit vertically opposed to each other when the both ends of the magnet roller and the both ends of the anvil roller contact with each other, wherein the roller gap change unit comprises: a slope formed on at least a part of one or both of the opposed surfaces of each pair of the first bearing unit and the second bearing unit; a stopper guided to move between a first position in which the stopper projects into the clearance and a second position in which the stopper retracts from the first position; and a stopper actuating mechanism attached to the frame so as to move the each of the stoppers, wherein each of the stoppers has an inclined surface engageable with the associated slope, and when each of the stoppers is located at the first position, the inclined surface of the stopper engages with the associated slope so that the both ends of the magnet roller and the both ends of the anvil roller separate from each other, and when each of the stoppers is located at the second position, the both ends of the magnet roller and the both ends of the anvil roller contact with each other, wherein the roller gap change unit further comprises a position adjusting mechanism provided for each of the stoppers and attached to the frame so as to be adjusted its position in a direction of linear movement of the associated stopper, and the leading end of the stopper contacts with the associated position adjusting mechanism when the stopper is located at the first position.

According to another preferred embodiment of the present invention, the stopper actuating mechanism is an air cylinder, and the stopper is fixed to a rod of the air cylinder. According to further preferred embodiment of the present invention, the stopper actuating mechanism is a solenoid actuator or a linear actuator including a motor as a drive source, and the stopper is fixed to an actuating element of the solenoid actuator or the linear actuator.

According to still further preferred embodiment of the present invention, the press mechanism comprises: a horizontal elongated roller support member extending above and parallel to the upper roller of the magnet and anvil rollers and movable in a vertical direction; and press screws vertically extending through the frame above both ends of the roller support member while engaging with the frame, wherein the press screws are attached to the roller support member so as to rotate around an axis thereof in their place, and the pairs of press rollers are supported by the both ends of the roller support member, and the pairs of press rollers are moved between the pressing position and the nonpressing position by the press screws being rotated in clockwise and counterclockwise directions.

Effect of the Invention

According to the present invention, at least one of the magnet and anvil rollers forms large diameter portions at its both ends and a small diameter portions at its intermediate portion, and the pair of the bearing units for the magnet roller and the pair of the bearings for the anvil rollers are movable in a vertical direction, and each end of the lower roller of the magnet and anvil rollers is supported by the pair of support rollers, the both ends of the upper roller of the magnet and anvil rollers can be pressed against the both ends of the lower roller. Further, a roller gap change unit is arranged to move the bearing unit for the upper roller between a position in which the both ends of the magnet roller and the both ends of the anvil roller contact with each other and a position in which the both ends of the magnet roller and the both ends of the anvil rollers separate from each other, and thereby it is possible to switch between two different sizes of gaps between the intermediate portions of the magnet and anvil rollers. Consequently, two different types of flexible dies whose height correspond to the two different sizes of the gap can be magnetically mounted on the intermediate portion of the magnet roller and therefore, so that two different types of flexible dies having different heights can be used in a single rotary die cutter.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a side view schematically showing a configuration of a rotary die cutter according to an embodiment of the present invention.

FIG. **2** is a perspective view illustrating a main part of a punching unit of the rotary die cutter shown in FIG. **1**.

FIG. **3**A is a perspective view of the punching unit shown in FIG. **2** as viewed from a downstream when each of stoppers is located at a first position.

FIGS. **3**B and **3**C are sectional views illustrating a situation of mounting of a flexible die when each of the stoppers is located at the first position.

FIG. **4**A is a side view of the punching unit shown in FIG. **3**A.

FIG. **4**B is a sectional view taken along an A-A line in FIG. **3**A.

FIG. **5**A is a side view of the punching unit shown in FIG. **2** as viewed from the downstream when each of the stoppers is located at a second position.

FIGS. **5**B and **5**C are sectional views illustrating a situation of mounting of a flexible die when the each of stoppers is located at the second position.

FIG. **6**A is side view of the punching unit shown in FIG. **5**A.

FIG. **6**B is a sectional view taken along an A-A line in FIG. **5**A.

BEST MODE FOR CARRYING OUT THE INVENTION

A preferred embodiment of the present invention will be described below with reference to accompanying drawings. FIG. **1** is a side view schematically showing a configuration of a rotary die cutter according to an embodiment of the present invention. Referring to FIG. **1**, a rotary die cutter according to the present invention comprises a sheet supply unit **1** supplying sheets S one by one from a sheet stack P, a conveyance unit **2** arranged downstream of the sheet supply unit **1** to convey the sheet S received from the sheet supply unit **1** while correcting the slant of the sheet S, a punching unit **3** arranged downstream of the conveyance unit **2**, an ejecting unit **4** arranged downstream of the punching unit **3** to eject the punched sheet S, and a controller **5** controlling operations of the sheet supply unit **1**, the conveyance unit **2**, the punching unit **3** and the ejecting unit **4**.

The sheet supply unit **1** comprises a horizontal shelf **1***a*, on which the sheet stack P is placed, arranged for a vertical movement, an elevating mechanism (not shown) moving the shelf **1***a*, and a suction conveyor unit **6** arranged above and opposite to the uppermost sheet S of the sheet stack P so as to suck the upper most sheet S and discharge it forward beyond a sheet alignment plate **1***b*. In this embodiment, the suction conveyor unit **6** is composed of a suction conveyor belt, but, for example, a suction rotor may be used in place of the suction conveyor belt. Although not shown in the drawings, a sensor for detecting height of the sheet stack P on the shelf **1***a* is provided, and, based on detection signals of the sensor, the shelf **1***a* is raised by an amount corresponding to decrease in the height of the sheet stack P each time the height of the sheet stack P decreases by a certain amount.

Then the suction conveyor belt **6** is circulated and the suction operation of the suction conveyor belt **6** is repeated at certain intervals while the shelf **1***a* is raised by degrees in order to constantly put the uppermost sheet S of the sheet stack P within the range of suction by the suction conveyor belt **6**, so that the sheets S are supplied one by one from the sheet supply unit **1**.

A pair of feed rollers **7***a*, **7***b* is arranged adjacent to the downstream end of the suction conveyor belt **6**. The pair of feed rollers **7***a*, **7***b* is constantly rotated in the direction in which the feed rollers **7***a*, **7***b* receive the sheet S from the suction conveyor belt **6**, and the suction conveyor belt **6** is stopped whenever the sheet S is nipped between the pair of feed rollers **7***a*, **7***b*. A first sensor **8** is arranged at the exit of the pair of feed rollers **7***a*, **7***b* so as to detect the leading end of the sheet S. Detection signals of the first sensor **8** are sent to the controller **5**.

In this embodiment, the conveyance unit **2** is composed of a suction conveyor belt **9**. Although not shown in the drawings, a publicly known slant correction unit is arranged on the conveying surface of the suction conveyor belt **9** so as to correct the slant of the sheet S conveyed. Thus the suction conveyor belt **9** performs the suction while circulating so that the sheet S supplied from the sheet supply unit **1** is conveyed to the punching unit **3** while being sucked by the suction conveyor belt **9** at the underside thereof.

FIG. **2** is a perspective view illustrating a main part of a punching unit of the rotary die cutter shown in FIG. **1**. FIG. **3**A is a perspective view of the punching unit shown in FIG. **2** as viewed from a downstream when each of stoppers is located at a first position, and FIGS. **3**B and **3**C are sectional views illustrating a situation of mounting of a flexible die when each of the stoppers is located at the first position. FIG. **4**A is a side view of the punching unit shown in FIG. **3**A, and FIG. **4**B is a sectional view taken along an A-A line in FIG. **3**A. FIG. **5**A is a side view of the punching unit shown in FIG. **2** as viewed from the downstream when each of the stoppers is located at a second position. FIGS. **5**B and **5**C are sectional views illustrating a situation of mounting of a flexible die when each of the stoppers is located at the second position. FIG. **6**A is side view of the punching unit shown in FIG. **5**A, and FIG. **6**B is a sectional view taken along an A-A line in FIG. **5**A.

Referring to FIGS. **2** through **6**, the punching unit **3** comprises a frame F provided with a path of the sheets S to be conveyed, a pair of first bearing units **10***a*, **10***b* arranged at both sides of the path and attached to the frame F so as to be moved in a vertical direction, a horizontal magnet roller **11** supported by the pair of first bearing units **10***a*, **10***b* and extending across and perpendicularly to the path, a pair of second bearing units **12***a*, **12***b* arranged under the pair of first bearing units **10***a*, **10***b* and attached to the frame F so as to be moved in a vertical direction, and a horizontal anvil roller **13** supported by the pair of second bearing units **12***a*, **12***b* and arranged opposite to the magnet roller **11**.

In this case, positional relationship between the magnet and anvil rollers **11**, **13** in a vertical direction is not limited to this embodiment, and the anvil roller **13** may be arranged above and opposite to the magnet roller **11**.

Each of the magnet and anvil rollers **11**, **13** forms large diameter portions **11***a*, **11***b*; **13***a*, **13***b* at its both ends and a small diameter portion **11***c*, **13***c* at its intermediate portion, the small diameter portion **11***c*, **13***c* extending between the large diameter portions **11***a*, **11***b*; **13***a*, **13***b*. In this embodiment, both of the magnet and anvil rollers **11**, **13** have the large and small diameter portions **11***a*-**11***c*; **13***a*-**13***c*, but, instead, it is possible to adopt the configuration that one of the magnet and anvil rollers **11**, **13** has the large and small diameter portions, and the other has a constant diameter along its length.

The punching unit **3** also comprises a pair of support rollers **14***a*, **14***b*; **15***a*, **15***b* attached to the frame F and arranged under and opposite to each of the large diameter portions **13***a*, **13***b* of the anvil roller **13** so as to support the anvil roller **13**. In this embodiment, under the anvil roller **13**, a pair of parallel rotary shafts **18***a*, **18***b* is supported by the frame F and extends parallel to the anvil roller **13**. On each of the rotary shafts **18***a*, **18***b*, a pair of the support rollers **14***a*, **15***a*; **14***b*, **15***b* is mounted to be rotated with the associated rotary shaft **18***a*, **18***b* in an integrated fashion.

The punching unit **3** also comprises a pair of press rollers **16***a*, **16***b*; **17***a*, **17***b* arranged above and opposite to each of the large diameter portions **11***a*, **11***b* of the magnet roller **11** so as to be moved between a pressing position in which the pairs of press rollers **16***a*, **16***b*; **17***a*, **17***b* press the large diameter portions **11***a*, **11***b* of the magnet roller **11** against the large diameter portions **13***a*, **13***b* of the anvil roller **13** and a nonpressing position in which the pairs of press rollers **16***a*, **16***b*; **17***a*, **17***b* retract upward from the pressing position, and a press mechanism attached to the frame F so as to support and move the pairs of press rollers **16***a*, **16***b*; **17***a*, **17** between the pressing position and the nonpressing position.

In this embodiment, the press mechanism comprises a horizontal elongated roller support member **19** extending above and parallel to the magnet roller **11** and movable in a vertical direction, and press screws **20** vertically extending through the frame F above both ends of the roller support member **19** while engaging with the frame F. The press screws **20** are attached to the roller support member **19** so as to rotate around an axis thereof in their place. The pairs of press rollers **16***a*, **16***b*; **17***a*, **17***b* are supported by the both ends of the roller support member **19**. The pairs of press rollers **16***a*, **16***b*; **17***a*, **17***b* are moved between the pressing position and the nonpressing position by the press screws **20** being rotated in clockwise and counterclockwise directions.

In this embodiment, each of the first and second bearing units **10***a*, **10***b*, **12***a*, **12***b* is square plate-shaped, and has a bearing body at its center. When the large diameter portions **11***a*, **11***b* of the magnet roller **11** and the large diameter portions **13***a*, **13***b* of the anvil roller **13** contact with each other, a clearance **23** is formed between each pair of the first bearing unit **10***a*, **10***b* and the second bearing unit **12***a*, **12***b* which are vertically opposed to each other.

The upper surface **22** of each of the second bearing units **12***a*, **12***b* extends horizontally while the lower surface **21** of each of the first bearing units **10***a*, **10***b* projects downwardly (toward the associated second bearing unit **12***a*, **12***b*) at the middle thereof so as to form a slope **21***a*. In this embodiment, a part of the lower surface **21** of each of the first bearing units **10***a*, **10***b* forms the slope **21***a*, but, according to the present invention, at least one of the opposed surfaces **21**, **22** of each pair of the first bearing unit **10***a*, **10***b* and the second bearing unit **12***a*, **12***b* which are vertically opposed to each other has only to be at least partially formed as a slope. Thus, for example, the whole of the lower surface **21** of each first bearing unit **10***a*, **10***b* may be formed as a slope, or both the lower surface **21** of each first bearing unit **10***a*, **10***b* and the upper surface **22** of each second bearing unit **12***a*, **12***b* may be at least partially formed as slopes. In the latter case, the slopes of the first and second bearing units **10***a*, **10***b*; **12***a*, **12***b* are opposed to each other so as to form wedge-shaped clearances therebetween.

In this embodiment, each of the first and second bearing units **10***a*, **10***b*; **12***a*, **12***b* is square plate-shaped, but the shape of the first and second bearing units **10***a*, **10***b*; **12***a*, **12***b* is not limited to this embodiment. Thus the first and second bearing units have arbitrary shapes in so far as the above-mentioned clearances and the above-mentioned slopes are formed.

The punching unit further comprises a roller gap change unit attached to the frame F and moving the first bearing units **10***a*, **10***b* between a position in which the both ends (in this embodiment, the large diameter portions **11***a*, **11***b*) of the magnet roller **11** and the both ends (in this embodiment, the large diameter portions **13***a*, **13***b*) of the anvil roller **13** contact with each other and a position in which the both ends of the magnet roller **11** and the both ends of the anvil roller **13** separate from each other so as to switch between two different sizes of gaps between the intermediate portions **11***c*, **13***c* of the magnet and anvil rollers **11**, **13**.

In this embodiment, the roller gap change unit has a stopper **24***a*, **24***b* provided for each pair of the opposed first and second bearing units **10***a*, **12***a*; **10***b*, **12***b*. Each of the stoppers **24***a*, **24***b* is guided to move between a first position in which the stopper **24***a*, **24***b* projects into the associated clearance **23** between the first and second bearing units **10***a*, **10***b*; **12***a*, **12***b* (see FIGS. **3** and **4**) and a second position in which the stopper **24***a*, **24***b* retracts from the first position (see FIGS. **5** and **6**). Each of the stoppers **24***a*, **24***b* is an elongated member having a square cross-section, and can slide in a horizontal direction along the upper surface **22** of the associated second bearing unit **12***a*, **12***b* at a flat side surface **29** thereof. Each of the stoppers **24***a*, **24***b* is also provided with a protruding portion **27** at the middle of the upper surface (a side surface opposite to the side surface **29**) thereof, and the upper surface of the protruding portion **27** forms an inclined surface **28** engageable with the slope **21***a* of the associated first bearing unit **10***a*, **10***b*.

The roller gap change unit also has an air cylinder **25***a*, **25***b* provided for each stopper **24***a*, **24***b* and attached to the frame F. The stopper **24***a*, **24***b* is fixed to the associated air cylinder **25***a*, **25***b*. Thus the air cylinders **25***a*, **25***b* cause a reciprocating slide motion of the pair of stoppers **24***a*, **24***b*, and as shown in FIGS. **3** and **4**, when the pair of stoppers **24***a*, **24***b* is located at the first position, the inclined surfaces **28** of the stoppers **24***a*, **24***b* engage with the slopes **21***a* of the first bearing units **10***a*, **10***b* so that the large diameter portions **11***a*, **11***b* of the magnet roller **11** and the large diameter portions **13***a*, **13***b* of the anvil rollers **13** separate from each other, on the other hand, as shown in FIGS. **5** and **6**, when the pair of stoppers **24***a*, **24***b* is located at the second position, the engagement between the inclined surfaces **28** of the stoppers **24***a*, **24***b* and the slopes **21***a* of the first bearing units **10***a*, **10***b* is released so that the large diameter portions **11***a*, **11***b* of the magnet roller **11** and the large diameter portions **13***a*, **13***b* of the anvil roller **11** contact with each other. In this case, it goes without saying that such slide motion of the pair of stoppers **24***a*, **24***b* is carried out when the pair of press rollers **16***a*, **16***b* is located at the nonpressing position.

Although not shown in the drawings, position detection sensors (for example, proximity sensors) detecting when the stoppers **24***a*, **24***b* are located at the first or second positions are attached to the frame F, and detection signals of the position detection sensors are sent to the controller **5**.

Thus the switching between two sizes of gaps G between the small diameter portion (intermediate portion) **11***c* of the magnet roller **11** and the small diameter portion (intermediate portion) **13***c* of the anvil roller **13** is achieved by switching between the first and second positions of the pair of stoppers **24***a*, **24***b*. As a result, two different types of flexible dies K whose heights correspond to the two different sizes of the gaps G can be magnetically mounted on the intermediate portion **11***c* of the magnet roller **11** (see FIGS. **3**B, **3**C, **5**B and **5**C).

The roller gap change unit further comprises a position adjusting mechanism **26***a*, **26***b* provided for each of the stoppers **24***a*, **24***b*. Each of the position adjusting mechanism **26***a*, **26***b* is arranged at a side of the frame F away from the air cylinder **25***a*, **25***b* and attached to the frame F so as to be adjusted its position in a direction of linear movement of the associated stopper **24***a*, **24***b*. The leading end of the stopper **24***a*, **24***b* contacts with the associated position adjusting mechanism **26***a*, **26***b* when the stopper **24***a*, **24***b* is located at the first position.

According to the present invention, the amount of the engagement between the slopes **21***a* of the first bearing units **10***a*, **10***b* and the inclined surfaces **28** of the stoppers **24***a*, **24***b* can be changed by the position adjusting mechanisms **26***a*, **26***b* and thereby the size of the gap G between the small diameter portion **11***c* of the magnet roller **11** and the small diameter portion **13***c* of the anvil roller **13** at the first position of the stoppers **24***a*, **24***b* can be easily changed or adjusted.

The configuration of the stoppers **24***a*, **24***b* is not limited to this embodiment. Thus the stoppers **24***a*, **24***b* may have any configuration adapted to shapes of the clearances between the pairs of the first bearing unit **10***a*, **10***b* and the second bearing unit **12***a*, **12***b* or shapes of the slopes of the lower and upper surfaces of the first and second bearing units **10***a*, **10***b*; **12***a*, **12***b*. In this embodiment, the air cylinder is used as a stopper actuating mechanism, but instead of the air cylinder, a solenoid actuator or a linear actuator including a motor as a drive source may be used, and each of the stoppers **24***a*, **24***b* is fixed to an actuating element of the solenoid actuator or the linear actuator.

In this embodiment, the roller gap change unit comprises the slope **21***a* formed at least one of the opposed surfaces **21**, **22** of the first and second bearing units **10***a*, **12***a*; **10***b*, **12***b* which are vertically opposed to each other, the stopper actuating mechanisms composed of the air cylinders **25***a*, **25***b*, and the position adjusting mechanisms **26***a*, **26***b*, but the configuration of the roller gap change unit is not limited to this embodiment. Thus the roller gap change unit may be any configuration in so far as the roller gap change unit can switch between two sizes of the gaps G between the intermediate portions **11***c*, **13***c* of the magnet and anvil rollers **11**, **13** by moving the first bearing units **10***a*, **10***b* in a vertical direction.

The switching of the size of the gap G is performed as follows. The controller **5** has a touch screen **5***a*, and for example, when preset sizes of the gap G are 0.8 mm and 1.0 mm, although not shown in the drawings, a button (an icon) marked "0.8 mm" and a button (an icon) marked "1.0 mm" are displayed on a screen for switch of gap size of the touch screen **5***a*. In this case, based on detection signals of the position detection sensors, the controller **5** indicates an operator which of the sizes is presently set by for example, highlighting one of the buttons.

Prior to the switching of the gap size, each pair of press rollers **16***a*, **16***b*; **17***a*, **17***b* is moved from the pressing position to the nonpressing position by the operator handling the press screws **20**. Then, for example, when the present size of the gap G is 0.8 mm, the operator touches the button marked "1.0 mm" on the touch screen **5***a*, and the controller **5** responds to this touching to move the stoppers **24***a*, **24***b* (from the second position to the first position in this case). After that, each of the pairs of press rollers **16***a*, **16***b*; **17***a*, **17***b* is moved from the nonpressing position to the pressing position by the operator handling the press screws **20**, and the switching of the gap size is completed.

Referring to FIG. **1** again, the anvil roller **13** is provided with a pulley **30** at a shaft thereof and a motor **31** is arranged below the anvil roller **13**. A drive shaft of the motor **31** is provided with a pulley **31***a* and extends parallel to the anvil roller **13**. A timing belt **32** extends between the pulleys **30**, **31***a*. The anvil roller **13** is rotated by the motor **31**. A shaft of the magnet roller **11** is coupled to the shaft of the anvil roller **13** through a connecting mechanism (not shown) in such a way that the magnet and anvil rollers **11**, **13** are rotated synchronously with each other at an equal circumferential velocity.

The motor **31**, the pulleys **30**, **31***a*, the timing belt **32** and the connecting mechanism (not shown) construct a first drive mechanism rotating the magnet and anvil rollers **11**, **13**.

A rotary encoder **34** is arranged between the anvil roller **13** and the motor **31**. A rotary shaft of the rotary encoder **34** is provided with a pulley **33** and extends parallel with the shaft of the anvil roller **13**. The pulley **33** contacts with the timing belt **32** so as to be rotated by the circulation of the timing belt **32**. The controller **5** detects a rotational position of the anvil roller **13**, that is, the magnet roller **11** (that is, the flexible die K) based on pulses outputted from the rotary encoder **34**.

The punching unit **3** further comprises a pair of feed rollers **35***a*, **35***b* arranged upstream of and at a distance from the pair of magnet and anvil rollers **11**, **13** and arranged adjacent to the downstream of the suction conveyor belt **2**. The pair of feed rollers **35**a, **35**b consists of a pair of rollers which are arranged opposite to each other in a vertical direction and extend parallel to the magnet and anvil rollers **11**, **13**.

A lower roller **35**b of the pair of feed rollers **35**a, **35**b is provided with a pulley **36** at a shaft thereof. A servo motor **37** is arranged below the lower roller **35**b, and a drive shaft of the servo motor **37** is provided with a pulley **37**a and extends parallel to the lower roller **35**b. A timing belt **38** extends between the pulleys **36**, **37**a so that the pair of feed rollers **35**a, **35**b are rotated by the servo motor **37**. The servo motor **37**, the pulleys **36**, **37**a and the timing belt **38** construct a second drive mechanism rotating the pair of feed rollers **35**a, **35**b.

Thus the magnet and anvil rollers **11**, **13** are constantly rotated in a direction to receive the sheet S from the pair of feed rollers **35**a, **35**b, and the sheet S fed from the suction conveyor belt (conveyance unit) **2** into a gap between the pair of feed rollers **35**a, **35**b is punched by the flexible die K while being conveyed by the pair of feed rollers **35**a, **35**b through the gap between the magnet and anvil rollers **11**, **13**.

A second sensor **40** is arranged downstream of the pair of feed rollers **35**a, **35**b so as to detect the passage of a leading end of the sheet S. Detection signals of the second sensor **40** are sent to the controller **5**. A flat support plate **39** is arranged between the pair of feed rollers **35**a, **35**b and the pair of magnet and anvil rollers **11**, **13** so as to support the underside of the sheet S conveyed by the pair of feed rollers **35**a, **35**b. The support plate **39** is provided if needed.

Thus before start of the motion of the rotary die cutter, the data about the punching of the sheet such as a size of the sheet S and a distance from the leading end of the sheet S to a leading end of a punching range on the sheet S is inputted to the controller **5** through the touch screen **5**a. Then the rotary die cutter starts the motion, and when a first sheet S is supplied from the sheet stack P by the sheet supply unit **1**, the controller **5** measures a time from when the suction conveyor belt **6** of the sheet supply unit **1** starts the motion till when the leading end of the first sheet S passes through the second sensor **40**. Thus a timing of sheet supply by the sheet supply unit **1**, that is, a timing of the motion of the suction conveyor belt **6** is corrected based on difference between the measured value and the preset value.

After that, subsequent sheets S after a second sheet S are supplied by the sheet supply unit **1** one by one at the corrected timing. The sheet S supplied from the sheet supply unit **1** is conveyed by the suction conveyor belt **2**, and fed from the suction conveyor belt **2** into the gap between the pair of feed rollers **35**a, **35**b. In this case, the suction conveyor belt **2** is constantly circulated.

In addition to the correction of the timing of sheet supply of the sheet supply unit **1**, the rotation of the pair of feed rollers **35**a, **35**b is controlled based on the detection signals of the second sensor **40**. Thus the sheet S fed to the pair of feed rollers **35**a, **35**b is conveyed to the gap between the magnet and anvil rollers **11**, **13** along the support plate **39** by the pair of feed rollers **35**a, **35**b. When the leading end of the sheet S passes through the second sensor **40**, based on the detection signal of the sensor **40**, the rotation of the pair of feed rollers **35**a, **35**b is controlled corresponding to a peripheral velocity and a rotational position of the flexible die K in such a manner that the leading end of the punching range on the sheet S coincides with the leading end of the flexible die K at the lowest point of the periphery of the magnet roller **11**.

The sheet supply to the pair of magnet and anvil rollers **11**, **13** at a precise timing by the control of the rotation of the pair of feed rollers **35**a, **35**b based on the detection signals of the second sensor **40** as well as the correction of the timing of sheet supply of the sheet supply unit **1**.

The ejecting unit **4** comprises a conveyor belt **41** extending from an exit of the pair of magnet and anvil rollers **11**, **13** to an exit of the rotary die cutter, a feed roller **42** arranged adjacent to the downstream of the conveyor belt **41**. The feed roller **42** extends perpendicularly to the conveyor belt **41** and contacts the conveyance surface of the conveyor belt **41**. The sheet S punched by the punching unit **3** is conveyed by the conveyor belt **41** and the feed roller **42** and discharged from the exit of the rotary die cutter.

DESCRIPTION OF REFERENCE NUMERALS

1 Sheet supply unit
1a Shelf
1b Sheet alignment plate
2 Conveyance unit (Suction conveyor belt)
3 Punching unit
4 Ejecting unit
5 Controller
5a Touch screen
6 Suction conveyor belt
7a, **7**b Pair of feed rollers
8 First sensor
9 Suction conveyor belt
10a, **10**b First bearing unit
11 Magnet roller
11a, **11**b Large diameter portion
11c Small diameter portion
12a, **12**b Second bearing unit
13 Anvil roller
13a, **13**b Large diameter portion
13c Small diameter portion
14a, **14**b, **15**a, **15**b Support roller
16a, **16**b, **17**a, **17**b Press roller
18a, **18**b Rotary shaft
19 Roller support member
20 Press screw
21 Lower surface
21a Slope
22 Upper surface
23 Clearance
24a, **24**b Stopper
25a, **25**b Air cylinder
26a, **26**b Position adjusting mechanism
27 Protruding portion
28 Inclined surface
29 Side surface
30 Pulley
31 Motor
31a Pulley
32 Timing belt
33 Pulley
34 Rotary encoder
35a, **35**b Pair of feed rollers
36 Pulley
37 Servo motor
38 Timing belt
39 Support plate
40 Second sensor
41 Conveyor belt
42 Feed roller
F Frame
G Gap
K Flexible die
P Sheet stack
S Sheet

The invention claimed is:

1. A rotary die cutter comprising:

a frame provided with a path of sheets to be conveyed;

a pair of first bearing units arranged at both sides of the path and attached to the frame;

one roller of a magnet roller and an anvil roller supported by the pair of first bearing units and extending across and perpendicularly to the path;

a pair of second bearing units arranged above the pair of first bearing units and attached to the frame so as to be moved in a vertical direction;

the other roller of the magnet roller and the anvil roller supported by the pair of second bearing units and arranged opposite to the one roller, at least one of the magnet and anvil rollers forming large diameter portions at both ends thereof and a small diameter portion at an intermediate portion thereof, the small diameter portion extending between the large diameter portions;

a pair of support rollers attached to the frame and arranged under and opposite to each end of the one roller so as to support the one roller;

a pair of press rollers arranged above and opposite to each end of the other roller so as to be moved between a pressing position in which the pairs of press rollers press the both ends of the other roller against the both ends of the one roller and a nonpressing position in which the pairs of press rollers retreat upward from the pressing position;

a press mechanism attached to the frame so as to support and move the pairs of press rollers between the pressing position and the nonpressing position;

a roller gap change unit attached to the frame and moving the bearing unit for the other roller between a position in which the both ends of the magnet roller and the both ends of the anvil roller contact with each other and a position in which the both ends of the magnet roller and the both ends of the anvil roller separate from each other so as to switch between two different sizes of gaps between the intermediate portions of the magnet and anvil rollers, two different types of flexible dies whose heights correspond to the two different sizes of the gaps being able to be magnetically mounted on the intermediate portion of the magnet roller;

a pair of feed rollers arranged upstream of a pair of the magnet and anvil rollers;

a first drive mechanism rotating the magnet and anvil rollers in such a way that the magnet and anvil rollers are rotated synchronously with each other at an equal circumferential velocity; and

a second drive mechanism rotating the pair of feed rollers,

wherein a clearance is formed between each pair of the first bearing unit and the second bearing unit vertically opposed to each other when the both ends of the ma net roller and the both ends of the anvil roller contact with each other,

wherein the roller map change unit comprises:

a slope formed on at least a part of one or both of the opposed surfaces of each pair of the first bearing unit and the second bearing unit;

a stopper guided to move between a first position in which the stopper projects into the clearance and a second position in which the stopper retracts from the first position; and

a stopper actuating mechanism attached to the frame so as to move the each of the stoppers,

wherein each of the stoppers has an inclined surface engageable with the associated slope, and when each of the stoppers is located at the first position, the inclined surface of the stopper engages with the associated slope so that the both ends of the magnet roller and the both ends of the anvil roller separate from each other, and when each of the stoppers is located at the second position, the both ends of the magnet roller and the both ends of the anvil roller contact with each other,

wherein the roller gap change unit further comprises a position adjusting mechanism provided for each of the stoppers and attached to the frame so as to be adjusted at a position thereof in a direction of linear movement of the associated stopper, and the leading end of stopper contacts with the associated position adjusting mechanism when the stopper is located at the first position,

wherein a sheet is supplied one by one between the pair of feed rollers, and punched by the flexible die while being conveyed through the gap between the magnet and anvil rollers by the pair of feed rollers.

2. The rotary die cutter according to claim **1**, wherein the stopper actuating mechanism is an air cylinder, and wherein the stopper is fixed to a rod of the air cylinder.

3. The rotary die cutter according to claim **1**, wherein the stopper actuating mechanism is a solenoid actuator or a linear actuator including a motor as a drive source, and wherein the stopper is fixed to an actuating element of the solenoid actuator or the linear actuator.

4. The rotary die cutter according to claim **1**, wherein the press mechanism comprises:

a horizontal elongated roller support member extending above and parallel to the other roller and movable in a vertical direction; and

press screws vertically extending through the frame above both ends of the roller support member while engaging with the frame, wherein

the press screws are attached to the roller support member so as to rotate around an axis thereof in their place, and the pairs of press rollers are supported by the both ends of the roller support member, and the pairs of press rollers are moved between the pressing position and the nonpressing position by the press screws being rotated in clockwise and counterclockwise directions.

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